

(19)日本国特許庁(JP)

(12) 公表特許公報(A)

(11)特許出願公表番号 特表2002-523901 (P2002-523901A)

(43)公表日 平成14年7月30日(2002.7.30)

(51) Int.Cl.7		識別記号	FΙ		テ・	-7]- *(参考)
H01L	21/822		H01L	27/10	461	5 B O 2 5
G11C	16/02			27/04	A	5 F O 3 8
H01L	21/8247		•		434	5 F O 8 3
	27/04			29/78	371	5 F 1 O 1
	27/10	461	G11C	17/00	601Z	
			審査請求 有 予修	常客查請求 有	(全 17 頁)	最終頁に続く

特願2000-566890(P2000-566890) (21)出願番号 平成11年8月18日(1999.8.18) (86) (22) 出顧日 平成13年2月16日(2001.2.16) (85)翻訳文提出日 PCT/EP99/06077 (86)国際出願番号 WO00/11719 (87)国際公開番号 平成12年3月2日(2000.3.2) (87)国際公開日 (31)優先権主張番号 98115550.0 (32) 優先日 平成10年8月18日(1998.8.18) (33)優先権主張国 欧州特許庁(EP) EP(AT, BE, CH, CY, (81) 指定国 DE, DK, ES, FI, FR, GB, GR, IE, I T, LU, MC, NL, PT, SE), BR, CN, I N, JP, KR, MX, RU, UA, US

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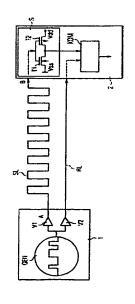
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(54) 【発明の名称】 表面被覆部を有する半導体チップ

(57)【要約】

半導体基板の少なくとも1つの層に実現された、少なくとも1つのグループに配置された回路と、少なくとも1つの当該回路グループを覆って配置されておりかつ前記回路(1, 2)のうちの少なくとも1つに電気的に接続されてた、少なくとも1つの導電性の保護層(SL)とを有する半導体チップにおいて、前記基板は少なくとも1つの保護センサ(SS)を有しており、この/これらの保護センサ(SS)はその/それらの検出端子によって、導電性の保護層(SL)または前記の導電性の保護層のうちの少なくとも1つに接続されており、この/これらの保護センサの出力端子は、前記回路のうちの少なくとも1つ(2)に接続されており、これによりこの/これらの保護センサの出力側に所定の、不揮発のレベルが印加される場合に、前記回路が決められた通りに機能しないようにされている。



【特許請求の範囲】

【請求項1】 半導体基板の少なくとも1つの層に実現された、少なくとも1つのグループに配置された回路と、少なくとも1つの当該回路グループを覆って配置されておりかつ前記回路(1,2)のうちの少なくとも1つに電気的に接続されてた、少なくとも1つの導電性の保護層(SL)とを有する半導体チップにおいて、

前記基板は少なくとも1つの保護センサ(SS)を有しており、

該保護センサは、該保護センサが状態を不揮発に記憶するように形成されてお り、

前記保護センサ(SS)は、検出端子によって前記の導電性の保護層(SL)または前記の導電性の保護層のうちの少なくとも1つに接続されており、

前記保護センサ (SS) の出力端子は、前記回路のうちの少なくとも1つ (2) に接続されており、これにより保護センサの出力側に所定の、不揮発のレベルが印加される場合に、前記回路が決められた通りに機能しないようにされていることを特徴とする

半導体チップ。

【請求項2】 保護センサ (SS) は、前記回路のトランジスタに比して極めて薄いゲート酸化物を有する少なくとも1つのトランジスタ (T1, T2) によって形成されており、

前記トランジスタ (T1, T2) のゲート端子は前記導電層 (SL) に接続されている

請求項1に記載の半導体チップ。

【請求項3】 保護センサは、不揮発性メモリセルとして形成されており、該メモリセルは、半導体基板のチャネル領域の両側に形成されたソース領域およびドレイン領域(10,11)と、少なくとも部分的にチャネル領域の上方に配置された、完全に絶縁されたゲート電極(12)と、該絶縁ゲート電極(12)の上方に配置された2つの制御ゲート電極(14,15)とによって形成されており、

前記制御ゲート電極の1つが前記検出端子(15)を形成しており、別の制御

ゲート電極 (14) ならびに拡散領域 (10, 11) が評価回路 (AWS) に接続されている

請求項1に記載の半導体チップ。

【請求項4】 前記絶縁ゲート電極 (12) は、正または負の電荷によって プリチャージされている

請求項3に記載の半導体チップ。

【請求項5】 複数の保護センサでは、異なる絶縁ゲート電極(12)は、 別個の電荷でプリチャージされている

請求項4に記載の半導体チップ。

【請求項6】 前記回路のうちの少なくとも1つは、少なくとも1つの検出 回路 (KOM) を有しており、

該検出回路は、保護センサー(S-S) の出力端子に接続されている 請求項1から5までのいずれか1項に記載の半導体チップ。

【発明の詳細な説明】

[0001]

本発明は半導体チップに関し、ここでこの半導体チップは、半導体基板の少なくとも1つの層に実現されておりかつ少なく1つのグループで配置された回路と、少なくとも1つのこのような回路グループを覆って配置されておりかつこれらの回路うちの少なくとも1つに電気的に接続されている、少なくとも1つ導電性の保護層とを有する。

[0002]

このような半導体チップは、EP0378306A2から公知である。そこに記載された半導体チップでは、第1回路グループが保護された領域に、また第2回路グループが保護されていない領域に配置されている。第1領域の保護は、この公知の半導体チップでは導電層によって行われ、これは第1回路グループの配線面を覆って配置されている。この導電層は回路グループに電気的に接続されており、この回路グループの通常の機能は、層に障害のない場合にだけ得られる。

[0003]

ここでは第1回路グループは、マイクロプロセッサと、所属の周辺回路、例えばメモリおよび伝送論理回路とを含む。このメモリには例えば秘密の情報があることがある。このマイクロプロセッサが、安全に関連する機能に殊に有利な固有の構造を有することもあり得る。損傷がないことが常時チェックされる導電層によって、例えば走査形電子顕微鏡による回路の動作中の探知が回避される。

[0004]

しかしながら事前にも事後にも、安全がクリティカルな領域を覆っていない保 護層を除去して、代替え線路を形成することが可能である。これによって、現在 は極めて繁雑な条件の下でだけで可能であるとしても、動作時の回路を検査する ことができる。

[0005]

EP0169941A1にもパッシベーション層を有する半導体回路が示されており、ここでこのパッシベーション層は等電位面としてその下にある回路部分を保護する。このパッシベーション層は、能動的な導体路として安全ロジックに

組み込まれており、このためそれを除去することによってチップの機能が妨げられ、動的な分析が不可能になる。しかしながら被覆のパッシベーション層の代わりに、パッシベーション層の線路機能を果たすが保護機能を果たさない一種のバイパス線路をうまく設けられれば、この公知の保護回路において半導体回路は再びアクティブ化される。

[0006]

EP0300864A2には、2つの部分層からなる導電性の保護層を設けることが記載されており、ここではこの部分層のキャパシタンスが評価される。このためにこの1つまたは2つの部分層を別の導電性構造によって置き換えることは簡単にはできないが、このキャパシタンスを、回路の少なくとも一部が露出した別の構造によって模倣することによって、安全対策を回避できる可能性がある。いずれにせよ半導体チップを少なくとも静的に検査するために、層を除去してあとで再びデポジットすることを後になって決定することはできない。

[0007]

層を除去しかつ新たな層、例えばバイパス線路をデポジットする 1 つの手法は、集束イオンビーム(FIB= focused-ion-beam)法である。これは元々、誤り除去および再構造化のために開発されたが、安全がクリティカルである半導体チップに対しては極めて危険である。

[0008]

したがって本発明の課題は、FIB作用に対して安全な半導体チップを提供することである。

[0009]

この課題は請求項1により、半導体チップの基板が少なくとも1つの保護センサを有しており、ここでこの保護センサは、これが状態を不揮発に記憶することができるように形成されており、この保護センサは、検出端子によって導電性の保護層または複数の導電性の保護層のうちの少なくとも1つに接続されており、この保護センサの出力端子が、複数の回路のうちの少なくとも1つの接続されており、これにより、保護センサの出力側に所定の不揮発のレベルが印加されている場合に、回路が決められた通りに機能しないようにすることによって解決され

る。

[0010]

この保護センサは有利には、回路のトランジスタに比して極めて薄いゲート酸化物を有するトランジスタとすることができる。しかし安全装置(ヒューズ)として動作する別の素子、例えばダイオードを使用することも可能である。保護センサとして機能する素子に重要なのは、これを電圧によって不揮発に変更できることである。

[0011]

ここで不揮発であるとは、記憶した状態が、給電電圧を遮断し、新たに再印加した後に維持されたままであることだけでなく、接続を形成する導電性の層の除去および再デポジットが検出されかつ記録されることでもある。したがって層に障害がない場合にも、これら先に除去されたか否か、またはそれに対する試みがなされた否かを決定することができる。

[0012]

すなわち示されたのは、FIB法によって処理した構造体が電気的に充電されることである。これによって形成された電圧は、保護センサによって検出され、1つまたは複数の回路の素子によって評価される。保護センサが、回路のトランジスタに比して極めて薄いゲート酸化物を有するトランジスタである場合、このゲート酸化物は、この電圧によりイオンビームによって破壊される。このことは簡単に評価することができる。

[0013]

保護センサは一方で面を覆うように半導体チップに分散することができ、他方でセンサの数はわずかで十分である。

[0014]

本発明の利点は殊に、保護層の除去が、後になってデポジットするバイパス線路との関連で(保護層の存在がチェックされる場合に)行われ得ないことである。それはこの保護センサは、保護層の除去をすでに不揮発に検出しており、したがってこの回路は機能せず、したがって保護層があってもなくても動作不能であるからである。ここで重要であるのは保護層での操作が不揮発に記憶されること

であり、これは例えばゲート酸化物の破壊によって行うことできる。

[0015]

本発明の別の形態では、保護センサは不揮発性のメモリセルとして構成されており、このメモリセルは、半導体基板のチャネル領域の両側に形成されたドレイン拡散領域およびソース拡散領域と、少なくとも部分的にチャネル領域の上方に配置された、完全に絶縁されたゲート電極と、このゲート電極の上方に配置された2つの制御ゲート電極とによって形成されている。これらの制御ゲート電極のうちの1つは、検出端子を形成し、別の制御ゲート電極ならびに拡散領域は評価回路に接続されている。

[0016]

この新しい不揮発性メモリセルではイオンビームが原因で発生した電圧によって、流れ出ることのできない、絶縁ゲートの電荷が変化する。第2制御ゲート端子ならびに拡散領域の端子を介してメモリセルのこの変化した状態はいつでも読み出すことができ、ひいては検出することができる。

[0017]

有利にはこの絶縁ゲートはプリチャージされ、ここで保護センサが複数の場合は、これらのプリチャージは別個の極性で行われ、これによって操作を確実に検出することができる。

[0018]

本発明を以下、実施例に基づき図面を用いて詳しく説明する。ここで、

図1は、保護層の実施例を示しており、

図2は、本発明の保護センサを有する評価回路例の基本回路図を示しており、

図3は、不揮発性メモリセルとして実施された本発明の保護センサの平面図を示しており、

図4は、不揮発性メモリセルに接続された評価回路の基本図を示している。

[0019]

図1には保護被覆が、2つの端子点A, Bを有するメアンダー状に延在する線路の形態で示されている。これは有利には、半導体回路に対する慣例の製造プロセスの最上部の金属位置 (Metallage) に実現される。これらの端子点A, Bは

、回路面に貫通してコンタクトしている。

[0020]

これらの端子点はその箇所で、図2に示したように回路に接続することができる。半導体チップにおいて送信装置1に構成された信号発生器GENは信号を形成し、この信号は、図示の実施例では増幅器V1, V2を介して図1に示したように保護線路SLおよび基準線路RLに供給される。保護回路の端子点Bは、CMOSインバータとして接続された、薄いゲート酸化物層を有する2つのトランジスタT1, T2のゲート端子に接続されており、ここでこれらのトランジスタは保護センサSSとして動作する。保護センサSSの出力側は、基準線路RLの第2端子と同様に比較器KOMの1つの入力側に接続されており、比較器KOMの出力信号は、保護センサSSが障害がないか否かを示す。ここで保護センサSSおよび比較器KOMは受信回路2を形成する。

[0021]

保護センサSSに障害がない場合、その出力側は基準線路RLと同じ信号を供給する。しかしながらこの保護センサが、イオンビーム作用による高すぎる電圧に起因して破壊されると、この出力側は一定の論理1または論理0を供給し、これが比較器KOMによって識別される。比較器KOMのこの出力信号から得られるのは、この半導体チップに実現された本来の回路が、それに決められた通りの機能をもはや果たすことができないことである。

[0022]

図3には、2つの制御ゲート電極を有する本発明の不揮発性メモリセルの基本図が平面図で示されている。電界効果トランジスタのドレインおよびソースとして機能する2つの拡散領域10,11の間に、詳しく図示しないチャネル領域が公知のように構成される。この領域は、絶縁ゲート電極12(いわゆる浮遊ゲート)の部分領域によって覆われている。チャネル領域と、ソース領域ないしはドレイン領域11との間の絶縁層、およびチャネル領域と絶縁ゲート電極12との間の絶縁層は、小さな領域において殊に薄く、そこにトンネル窓13を形成している。絶縁ゲート電極12の第1領域を覆って第1制御ゲート電極14が、また第2領域を覆って第2制御ゲート電極15が配置されている。拡散領域10,1

1および制御ゲート電極 14, 15 はそれぞれ、端子A, A', B, B' ないしはCを有する。

[0023]

この新しいメモリセルは有利にも、図2の薄いゲート酸化物を有するトランジスタの代わりに使用することができる。この場合、このメモリセルの端子Cは、保護線路SLの端子Bに接続することができる。メモリセルの端子Bと、メモリセルの拡散領域の端子A、A′は、一方では絶縁ゲート電極にプリチャージするために使用され、他方ではこの絶縁ゲート電極の充電状態を評価するために、評価回路AWSに接続されている。これは図4に示されている。

[0024]

このプリチャージは、本発明の有利な実施形態では、半導体チップの出荷の前にテストフェーズ中に、例えば16Vの高いプログラム電圧を、絶縁ゲート電極の第1制御ゲート電極14の端子BまたはB′の1つと、拡散領域11の端子Aとの間に印加することによって行われる。この充電によってメモリトランジスタの所定の初期電圧が生じる。したがってこの初期電圧は、絶縁ゲート電極の電荷に対する尺度である。FIBが作用すると、第2制御ゲート電極15とチャネル領域との間に電圧が形成される。この電圧によってトンネル窓13を通るトンネル電流が発生し、ひいては絶縁ゲート電極12の電荷が変化する。電荷のこの変化は、初期電圧を求めることにより評価回路AWSによって検出することができる。これはそれ自体変化する読み出し電圧を第1制御ゲート電極14に印加することによって行われる。変化した初期電圧は、絶縁ゲート電極の電荷が変化したことを意味する。

[0025]

このようにしてFIB作用が不揮発に保持されると、この半導体チップのつぎの動作時に適切な防御機構を起動することができる。

[0026]

絶縁ゲート電極12には正の電荷または負の電荷をプリチャージしてもよく、 複数の保護センサでは異なる数および極性の電荷をプリチャージすることができ 、これによってFIB作用の検出の確実性を高めることができる。 [0027]

保護センサに関連して保護層を本発明にしたがって使用すると殊に有利であるのは、この保護センサが保護層のイオンビーム検査を不揮発に記憶し、したがってこの保護層の後の修復または相応するバイパス線路によっては、半導体チップの決められた通りの機能がもはや生じ得ないことである。

【図面の簡単な説明】

【図1】

保護層の実施例を示す図である。

【図2】

本発明の保護センサを有する評価回路例の基本回路図である。

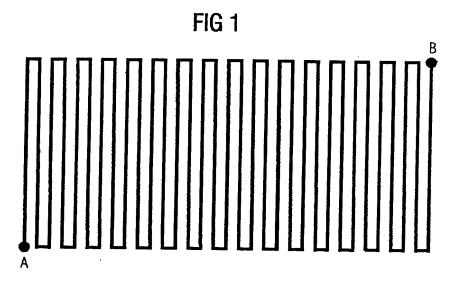
【図3】

不揮発性メモリセルとして実施された本発明の保護センサの平面図である。

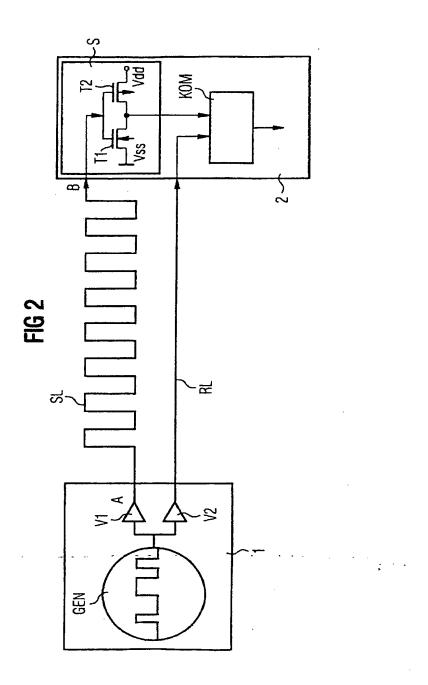
【図4】

不揮発性メモリセルに接続された評価回路の基本図である。

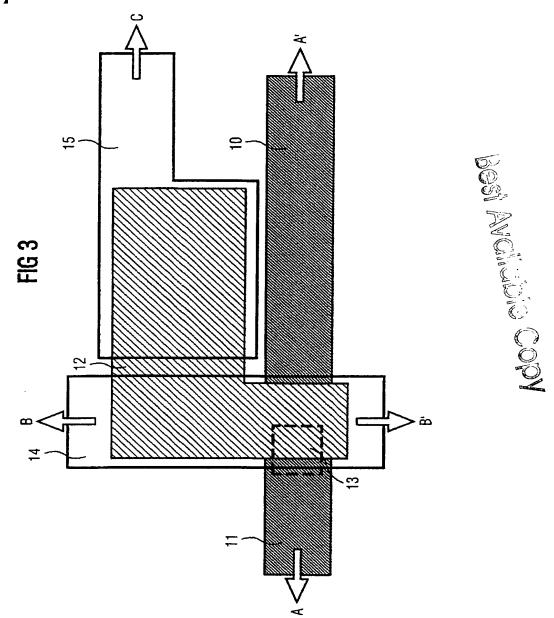
【図1】



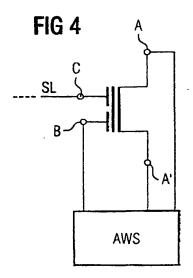
【図2】



【図3】



【図4】



【国際調査報告】

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(71) 出版人 インフィネオン テクノロジース アクチェンゲゼルシャフトドイツ選邦共和国 ミュンヘン ザンクトマルティン シュトラーセ 53 (72) 発明者 ミヒャエル スモーラドイツ選邦共和国 ミュンヘン ユタシュトラーセ 17 エリック・ロージャー ブリュックルマイアー

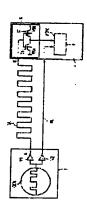
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(54) 【発明の名称】 表面被覆部を有する半導体テップ

(57) 【要約】

中導係基複の少なくとも1つの間に変現された、少なくとも1つのグループに配置された圏隣と、少なくとも1つの当鉄回路グループを覆って配置されておりかつ前記 国路(1.2)のうちの少なくとも1つに電気的に親戚されてた、少なくとも1つの線電性の発表層(SL)とを有する半導体チップにおいて、前記を減し少ととも1つの保護センサ(SS)はその/それらの負担増子によって、導電性の保護形(SL)または前記の導電性の保護形のうちの少なくとも1つに接触されており、この/これらの保護センサの出力増子は、前記回路のうちの少なくとも1つ(2)に接続されており、これによりこの/これらの保護センサの出力側に所定の、不評略のレベルが印加される場合に、前記回路が決められた遭りに機能しないようにされている。



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- 1. This document has been translated by computer. So the translation may not reflect the original precisely.
- 2.**** shows the word which can not be translated.
- 3. In the drawings, any words are not translated.

CLAIMS

[Claim(s)]

[Claim 1] The circuit arranged at at least one group realized by at least one layer of a semi-conductor substrate, In the semiconductor chip which at least one circuit group concerned is covered, and it is arranged, and connected with at least one of said circuits (1 2) electrically and which has at least one conductive protective layer (SL) Said substrate has at least one protection sensor (SS). This protection sensorIt is formed so that this protection sensor may memorize a condition un-volatilizing. Said protection sensor (SS) The detection terminal connects with at least one of the aforementioned conductive protective layer (SL) or the aforementioned conductive protective layers. The output terminal of said protection sensor (SS) When it connects with at least one of said circuits (2) and non-volatilized level [predetermined] is impressed to the output side of a protection sensor by this, it is characterized by trying not to function as said circuit was decided. Semiconductor chip.

[Claim 2] The protection sensor (SS) is formed of at least one transistor (T1, T2) which has very thin gate oxide as compared with the transistor of said circuit. The gate terminal of said transistor (T1, T2) is connected to said conductive layer (SL). Semiconductor chip according to claim 1.

[Claim 3] The protection sensor is formed as a non-volatile memory cell. This memory cellThe source field and drain field (10 11) which were formed in the both sides of the channel field of a semi-conductor substrate, The gate electrode which has been partially arranged above the channel field at least and which was insulated completely (12), It is formed with two control gate electrodes (14 15) arranged above this insulated-gate electrode (12). One of said the control gate electrodes forms said detection terminal (15), and another control gate electrode (14) and the diffusion field (10 11) are connected to the weighting network (AWS). Semiconductor chip according to claim 1.

[Claim 4] Said insulated-gate electrode (12) is precharged by forward or negative charge. Semiconductor chip according to claim 3.

[Claim 5] By two or more protection sensors, a different insulated-gate electrode (12) is precharged with the separate charge. Semiconductor chip according to claim 4.

[Claim 6] At least one of said circuits has at least one detector (KOM). This detector is connected to the output terminal of a protection sensor (SS). Semiconductor chip given in any 1 term to claims 1-5.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

this invention covers and stations the circuit arranged into one group this semiconductor chip is realized by at least one layer of a semi-conductor substrate, and few, and such at least one circuit group about a semiconductor chip here -- having -- **** -- and these circuits -- it has at least the protective layer of one conductivity electrically connected [inner] to at least one.

[0002]

Such a semiconductor chip is well-known from EP 0378306A2. In the semiconductor chip indicated there, it is arranged to the field where the 2nd circuit group is not taken care of again to the field to which the 1st circuit group was taken care of. Protection of the 1st field is performed by the conductive layer with this well-known semiconductor chip, and this covers the 1st circuit group's wiring side, and is arranged. This conductive layer is electrically connected to

the circuit group, and this circuit group's usual function is obtained only when there is no failure in a layer.
[0003]

Here, the 1st circuit group includes a microprocessor, and the circumference circuit of affiliation, for example, memory, and a transmission logical circuit. There may be information on a secret in this memory. This microprocessor may have the structure of a proper especially advantageous to the function relevant to insurance. Working detection of the circuit by the scanning electron microscope is avoided by the conductive layer by which it is always confirmed that there is no damage.

[0004]

However, it is able for insurance to remove the protective layer which has not covered the critical field to beforehand and after the event, and to form an alternative track in them. By this, though it is possible only under very complicated conditions now, the circuit at the time of actuation can be inspected.

[0005]

The semiconductor circuit which has a passivation layer is shown also in EP 0169941A1, and this passivation layer protects the circuit part which is in the bottom of it as the equipotential surface here. a conductor with this active passivation layer -- it is included in insurance logic as a way, and by removing it for this reason, the function of a chip is barred and dynamic analysis becomes impossible. However, although the track function of a passivation layer is achieved, if a kind of bypass track which does not achieve a protection feature can be well established instead of the passivation layer of covering, in this well-known protection network, a semiconductor circuit will be again made active.

[0006]

Preparing the conductive protective layer set to EP 0300864A2 from two partial layers is indicated, and the capacitance of this partial layer is evaluated here. For this reason, although it cannot perform simply replacing one or these two partial layers according to another conductive structure, a safety practice may be avoidable by copying this capacitance according to another structure which a part of circuit [at least] exposed. Anyway, in order to inspect a semiconductor chip statically at least, it cannot become behind and cannot determine to remove a layer and to carry out a deposit again later.

the one technique of removing a layer and carrying out the deposit of a new layer, for example, the bypass track, -- a focused ion beam (FIB=focused-ion-beam) -- it is law. From the first, although this was developed for error removal and restructuring, the insurance of it is very dangerous to a critical semiconductor chip.

Therefore, the technical problem of this invention is offering a safe semiconductor chip to an FIB operation. [0009]

By claim 1, as for this technical problem, the substrate of a semiconductor chip has at least one protection sensor. Here this protection sensorIt is formed so that this can memorize a condition un-volatilizing. This protection sensorIt connects. it connects with at least one of a conductive protective layer or two or more conductive protective layers with a detection terminal -- having -- ****
-- the output terminal of this protection sensor -- at least one of two or more circuits -- therebyWhen the level which is not volatilized [predetermined] is impressed to the output side of a protection sensor, it is solved by making it not function as the circuit was decided.
[0010]

This protection sensor can be advantageously used as the transistor which has very thin gate oxide as compared with the transistor of a circuit. However, it is also possible to use another component which operates as a safety device (fuse),

for example, diode. It is important for the component which functions as a protection sensor that this can be changed into un-volatilizing with an electrical potential difference.

[0011]

It is also that the removal and the re-deposit of a conductive layer which form not only being maintained after the condition of having not volatilized here and having memorized intercepts an electric supply electrical potential difference and newly re-impresses but connection are detected and recorded. Therefore, also when there is no failure in a layer, it can determine whether to be the no by which the attempt to whether it was removed by these points and it was made.

[0012]

That is, it was shown that the structure processed by the FIB method is charged electrically. The electrical potential difference formed of this is detected by the protection sensor, and is estimated by the component of one or more circuits. When a protection sensor is the transistor which has very thin gate oxide as compared with the transistor of a circuit, this gate oxide is destroyed by the ion beam with this electrical potential difference. This can be evaluated easily.

[0013]

A protection sensor can be distributed to a semiconductor chip so that a field may be covered by one side, and the number of sensors comes out only and is enough on the other hand.

[0014]

The advantage of this invention is that removal of a protective layer must have been especially performed in connection with the bypass track which becomes behind and carries out a deposit (when existence of a protective layer is checked). It is because actuation is impossible even if this protection sensor has already detected removal of a protective layer in it un-volatilizing, this circuit does not function, therefore there is a protective layer and there is nothing. It is important that actuation by the protective layer is memorized by un-volatilizing here, and by destruction of for example, a gate oxide, this is performed and can carry out things.

With another gestalt of this invention, the protection sensor is constituted as a memory cell of a non-volatile, and this memory cell is formed with the drain diffusion field and source diffusion field which were formed in the both sides of the channel field of a semi-conductor substrate, the gate electrode which has been partially arranged above the channel field at least and which was insulated completely, and two control gate electrodes arranged above this gate electrode. One of these control gate electrodes forms a detection terminal, and another control gate electrode and the diffusion field are connected to the weighting network.

[0016]

In this new non-volatile memory cell, the charge of the insulated gate into which an ion beam cannot flow with the electrical potential difference generated owing to changes. Through the 2nd control gate terminal and the terminal of a diffusion field, this condition of a memory cell of having changed can be read at any time, as a result can be detected.

[0017]

Advantageously, this insulated gate is precharged, and when a protection sensor is plurality here, these precharge is performed with a separate polarity and can detect actuation certainly by this.

[0018]

This invention is hereafter explained in detail using a drawing based on an example. Here Drawing 1 shows the example of a protective layer. Drawing 2 shows the basic circuit diagram of the example of a weighting network which has the protection sensor of this invention. Drawing 3 shows the top view of the protection sensor of this invention carried out as a non-volatile memory cell.

Drawing 4 shows the fundamental map of the weighting network connected to the non-volatile memory cell.

[0019]

Protective covering is shown to drawing 1 by the gestalt of the track which extends in the shape of [which has two terminal points A and B] a meander. This is realized advantageously in the metal location (Metallage) of the topmost part of the manufacture process of the practice over a semiconductor circuit. These terminal points A and B penetrate and are in contact with the circuit side.

[0020]

These terminal points are the part, and as shown in drawing 2, they can be connected to a circuit. The signal generator GEN constituted by the sending set 1 in the semiconductor chip forms a signal, and in the example of illustration, this signal is supplied to the guard-wire way SL and the datum-line way RL, as shown in drawing 1 through amplifier V1 and V2. The terminal point B of a protection network is connected to the gate terminal of two transistors T1 and T2 which have a thin gate oxide layer connected as a CMOS inverter, and these transistors operate as a protection sensor SS here. The output side of the protection sensor SS is connected to one input side of Comparator KOM like the 2nd terminal of the datum-line way RL, and the output signal of Comparator KOM shows whether there is [the protection sensor SS] any failure. The protection sensor SS and Comparator KOM form a receiving circuit 2 here.

When there is no failure in the protection sensor SS, the output side supplies the same signal as the datum-line way RL. However, if this protection sensor originates in the too high electrical potential difference by ion beam operation and is destroyed, this output side will supply fixed logic 1 or logic 0, and this will be identified by Comparator KOM. It is obtained from this output signal of Comparator KOM that a function as the original circuit realized by this semiconductor chip was decided to be it cannot be achieved any longer.

[0022]

The fundamental map of the non-volatile memory cell of this invention which has two control gate electrodes is shown to drawing 3 by the top view. The channel field which is not illustrated in detail between two diffusion fields 10 and 11 which function as the drain and the source of a field-effect transistor is constituted so that it may be well-known. This field is covered with the subregion of the insulated-gate electrode 12 (the so-called floating gate). The insulating layer between a channel field, and a source field or the drain field 11 and the insulating layer between a channel field and the insulated-gate electrode 12 are especially thin in a small field, and form the tunnel aperture 13 there. The 1st field of the insulated-gate electrode 12 is covered, the 1st control gate electrode 14 covers the 2nd field again, and the 2nd control gate electrode 15 is arranged. The diffusion fields 10 and 11 and the control gate electrodes 14 and 15 have Terminal A, A', B, B', or C, respectively.

[0023]

This new memory cell can be used instead of the transistor which has gate oxide with also advantageously thin drawing 2. In this case, the terminal C of this memory cell is connectable with the terminal B of the guard-wire way SL. The terminal B of a memory cell, the terminal A of the diffusion field of a memory cell, and A' are connected to the weighting network AWS in order to be used in order to precharge to an insulated-gate electrode, and to evaluate the charge condition of this insulated-gate electrode on the other hand. This is shown in drawing 4.

[0024]

This precharge is performed with the advantageous operation gestalt of this invention by impressing the high program electrical potential difference of 16V during a test phase before shipment of a semiconductor chip between one of the

terminal B of the 1st control gate electrode 14 of an insulated-gate electrode, or the B', and the terminal A of the diffusion field 11. The predetermined initial voltage of a memory transistor arises by this charge. Therefore, this initial voltage is a scale over the charge of an insulated-gate electrode. An operation of FIB forms an electrical potential difference between the 2nd control gate electrode 15 and a channel field. The tunnel current which passes along the tunnel aperture 13 with this electrical potential difference occurs, as a result the charge of the insulated-gate electrode 12 changes. This change of a charge is detectable by asking for initial voltage with a weighting network AWS. This is performed by impressing the read-out electrical potential difference which changes in itself to the 1st control gate electrode 14. The initial voltage which changed means that the charge of an insulated-gate electrode changed.

[0025]

Thus, if an FIB operation is held un-volatilizing, a defense mechanism suitable at the time of actuation next to this semiconductor chip can be started.

[0026]

Positive charge or negative charge may be precharged to the insulated-gate electrode 12, by two or more protection sensors, a different number and a different polar charge can be precharged, and this can raise the certainty of detection of an FIB operation.

[0027]

When a protective layer is used according to this invention in relation to a protection sensor, it is especially advantageous that a function as the semiconductor chip was decided depending on the bypass track on which this protection sensor memorizes ion beam inspection of a protective layer un-volatilizing, therefore it restores or ****s after this protective layer cannot arise any longer.

[Brief Description of the Drawings]

[Drawing 1]

It is drawing showing the example of a protective layer.

[Drawing 2]

It is the basic circuit diagram of the example of a weighting network which has the protection sensor of this invention.

[Drawing 3]

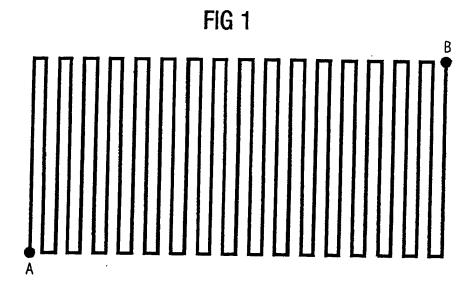
It is the top view of the protection sensor of this invention carried out as a non-volatile memory cell.

[Drawing 4]

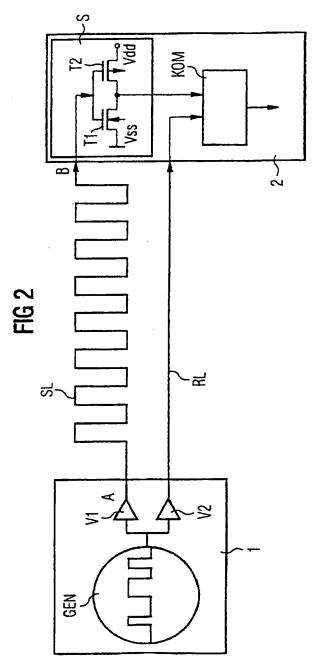
It is the fundamental map of the weighting network connected to the non-volatile memory cell.

DRAWINGS

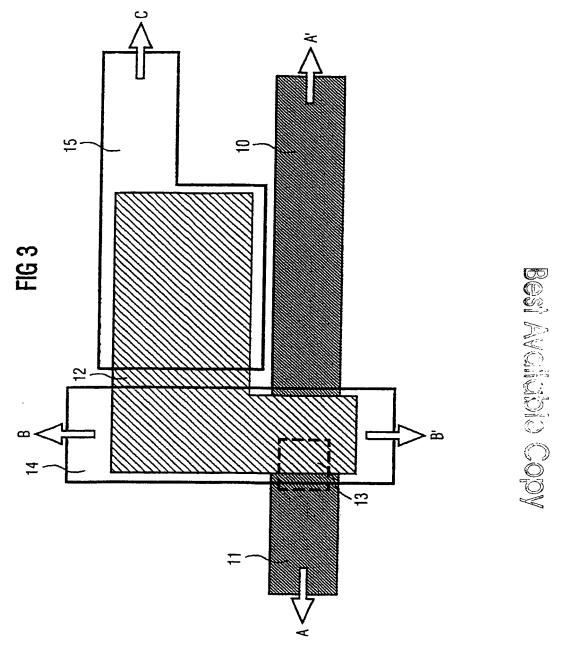
[Drawing 1]



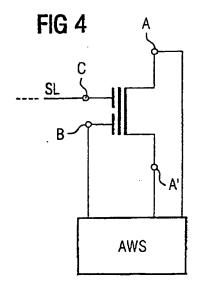
[Drawing 2]



[Drawing 3]



[Drawing 4]



Docket # (P2001 0166
Applic. # 101651, 601
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